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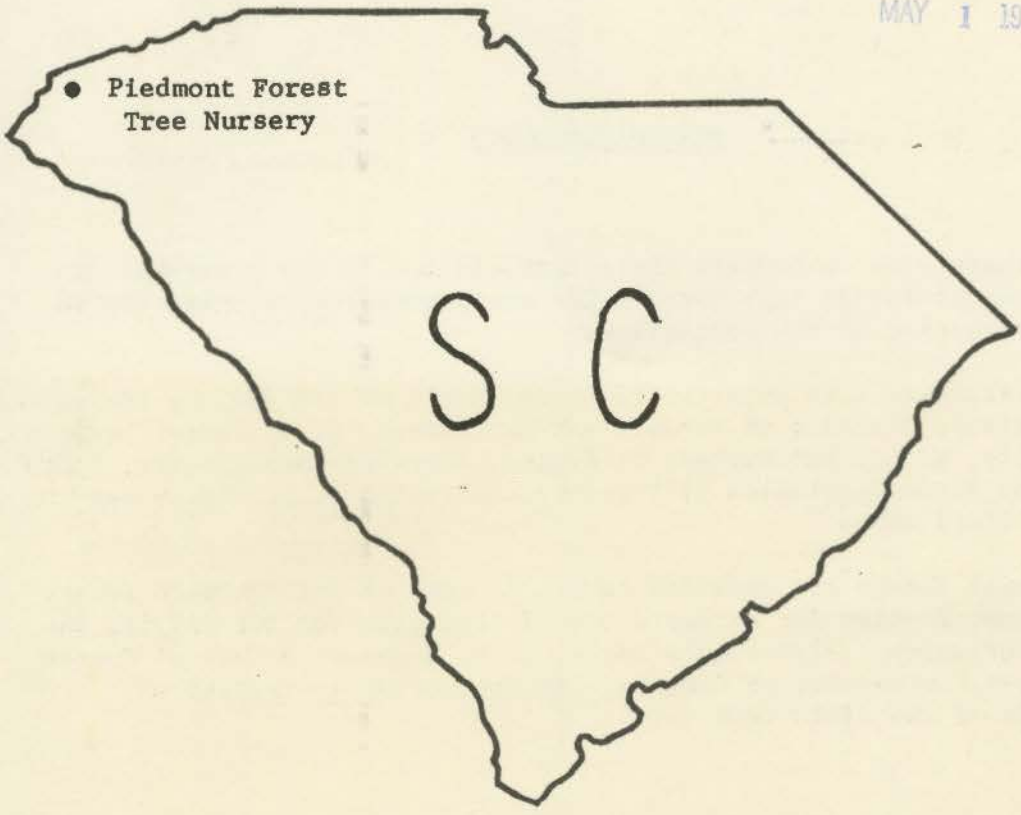

by

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in cooperation with

U. S. DEPARTMENT OF AGRICULTURE - FOREST SERVICE
SOUTHEASTERN AREA, STATE AND PRIVATE FORESTRY
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P. O. Box 5895, Asheville, N. C. 28803

April 1974
(150)

ACKNOWLEDGEMENTS

The authors wish to express their appreciation to the personnel of the Piedmont Forest Tree Nursery for their excellent cooperation in the application of the fungicides.

Appreciation is also extended to Elinor Earle and Tom Gentry, Biological Technicians, Division of Forest Pest Management, U. S. Forest Service, Asheville, N. C., and Michael C. Remion, Forester-Entomologist, South Carolina State Commission of Forestry, Columbia, S. C. who helped gather field data.

Additional thanks are extended to Mr. Al Kais of the Southern Forest Experiment Station for attempts toward isolating and identifying the causal organism. Also thanks to Dr. L. V. Pienaar, School of Forest Resources, University of Georgia, for conducting a statistical analysis of the field test data.

AN EVALUATION OF FIVE FUNGICIDES FOR CONTROL OF A WHITE PINE FOLIAGE DISEASE AT THE PIEDMONT FOREST TREE NURSERY IN SOUTH CAROLINA

By

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ABSTRACT

The fungicide Maneb, applied seven times during the growing season, was significantly more effective than four other fungicides in controlling white pine foliage disease during the 1973 growing season at the Piedmont Forest Tree Nursery near Salem, S. C. Other fungicides tested at the same application rate were Daconil, Topsin M, Ferbam and Bordeaux mixture. Although Maneb was the most effective of the five treatments tested, it did not give the degree of control required by most nurserymen. Computed disease ratings for the other four materials tested were not significantly different from the computed disease ratings for non-treated seedlings in the sampled isolation strips. Heavy rainfall during the 30-day period prior to initiation of disease symptoms undoubtedly contributed to significantly increased disease spread and severity. Therefore, more frequent fungicide applications may be required during periods of excessive rainfall to adequately control the disease.

INTRODUCTION

Since the 1960's, a white pine foliage disease has produced serious problems in forest tree nurseries in the Southeast. Disease outbreaks have occurred at the Pinson State Forest Nursery near Jackson, Tennessee since 1960, reaching their worst intensity in 1971 when 1,000,000 seedlings were infected. As a result of this infection approximately half of these trees were rendered unsaleable and were culled. Similar disease outbreaks have occurred at the Ralph Edwards State Forest Nursery near Morganton, N. C. for the past three years. In 1973 at the latter nursery, approximately one million trees were infected. In 1972 forty thousand seedlings were similarly affected at the Piedmont Forest Tree Nursery near Salem, S. C. These seedlings were held over in the nursery seedbeds until the 1973 season.

Early symptoms of the disease are necrotic spots (yellow turning to brown) on the needles surrounded by a pale area providing a haloed appearance. Needle tissue dies from these spots toward the tip (1/3 to 2/3 of distal portion dies) resulting in a scorched appearance of the tree seedlings.

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In an effort to prevent further loss from the disease, the Tennessee Division of Forestry applied Daconil, Topsin M and Bordeaux mixture three times during the 1971 growing season to diseased white pine at the Pinson Nursery. Bordeaux mixture produced satisfactory control results, but Daconil and Topsin M did not (Affeltranger 1973). Since Daconil and Topsin M have shown promise in controlling other foliage diseases, the South Carolina State Commission of Forestry considered these fungicides worthy candidates for further field testing. Consequently, five different fungicides were tested during the 1973 growing season at the Piedmont Nursery for their relative effectiveness in controlling the disease on 2-0 white pine seedlings. The Division of Forest Pest Management, Forest Service, Asheville, N. C., assisted in monitoring and evaluating the effectiveness of these fungicides in controlling the disease.

MATERIALS AND METHODS

Description of Fungicides Tested

Daconil (tetrachloroisophthalonitrile) - A 75-percent wettable powder produced commercially by the Diamond Alkali Company. This fungicide has very low mammalian toxicity (oral LD_{50} to rats is greater than 10,000 mg/kg) and exhibits good residual fungicidal properties. It is noncorrosive and poses no problem to spray equipment. Daconil was applied at the dosage rate of 2 pounds per 100 gallons of water. No phytotoxicity on pine has been observed at this dosage rate.

Topsin M (1, 2 - Bis (3-methoxy-carbonyl-2-thioureida) benzene) - A 70-percent wettable powder that originated at Nippon Soda Company, Ltd., (Japan) laboratories. This fungicide also has shown a very low mammalian toxicity (oral LD_{50} to rats is approximately 7,000 mg/kg) and exhibits long residual fungicidal effectiveness. In addition, tests on gnawing mammals revealed no skin or eye irritations. Topsin M has also shown miticidal and systemic fungicidal properties in controlling fungal plant pathogens. The dosage rate of Topsin M was 3/4 pound per 100 gallons of water. No phytotoxicity effects have been observed at this dosage rate with this fungicide. It is also noncorrosive and poses no problem to spray equipment.

Ferbam (Ferric dimethyldithiocarbamate) - A 50-percent wettable powder produced commercially by R. T. Vanderbilt Company, Inc. This fungicide also has a low mammalian toxicity rating (oral LD_{50} to rats is 17,000 mg/kg). Ferbam has become well established as an effective preventive fungicide for a number of plant diseases, especially in southern forest tree nursery spray programs for the control of fusiform rust on pine tree seedlings. Ferbam was applied in this test at the rate of 1.5 lbs. per 100 gallons of water. This fungicide also poses no corrosive problem to spray equipment, and no phytotoxicity to pine foliage has been observed at this dosage rate.

Maneb (Manganese ethylenebisdithiocarbamate). A product of E. I. DuPont Chemical Company commercially available as an 80-percent wettable powder. Maneb is also referred to as Manzate D Maneb fungicide. This fungicide also has a very low mammalian toxicity rating (oral LD_{50} to rats is 7,500 mg/kg). Maneb was applied at the dosage rate of 1.5 lbs. per 100 gallons of water. Maneb also poses no corrosive problem to spray equipment and no phytotoxicity to pine foliage has been observed at the above dosage rate.

A 4-4-50 Bordeaux mixture (4 lbs. copper sulphate, 4 lbs. hydrated lime and 50 gallons water) applied at the rate of 60 gallon per acre is one of the currently registered recommendations for the control of needle casts and blights on pine seedling species. This chemical was included in the present test to serve as a comparison to evaluate the efficacy of the other four chemicals. Bordeaux mixture

has a comparatively medium mammalian toxicity rating (oral LD_{50} to rats is 300 mg/kg). However, this fungicide has a major disadvantage of being very corrosive to spray equipment.

All five fungicidal sprays tested were applied to the point of runoff on the pine foliage. Commercial spreader-stickers were used with all fungicides except Bordeaux mixture.

Acquisition of Fungicides

Daconil was acquired for this evaluation as a complimentary experimental sample from the Diamond Shamrock Chemical Company in Cleveland, Ohio.

Topsin M was acquired from the Pennwalt Corporation in Montgomery, Alabama as a complimentary experimental sample.

The other three chemicals were purchased from local chemical supply outlets or were acquired from the existing stock supply (viz. Ferbam) at one of the S. C. State Commission of Forestry forest tree nurseries.

Test Design

Fifteen test plots, 3 replications of each of the five chemicals, each plot with dimensions of 4 ft. by 35 ft. were established as a completely randomized test design in the 2-0 white pine nursery beds at the Piedmont Forest Tree Nursery (Figure 1). A 10 ft. isolation strip was located between all plots within each bed (except that 50-foot strips were laid out between plots 5, 11 and 13) to minimize the possibility of spray treatment overlap. The 50-foot isolation strips were required to prevent the location of plots in low seedling density portions of the beds.

These isolation strips also served as non-treated control plots for comparison with the treated plots.

Treatments

The five fungicides were sprayed on their respective treatment plots according to the following schedule:

Initial sprays applied April 30 and May 2
Second sprays applied June 11
Third sprays applied July 2
Fourth sprays applied August 3
Fifth sprays applied August 28
Sixth sprays applied September 12
Seventh sprays applied September 24

A hydraulic sprayer containing a wooden tank was used to apply the chemicals. The spray rig was run at 80 psi.

Data Collections and Test Evaluation

Field observations and data collections were made on the test plots on October 16, 1973. The evaluation method used was a modification of a method developed by a New Zealand researcher (Jancarik, 1969). The method involves calculation of the disease rate by determining an average disease severity per tree and multiplying this figure by the percentage of diseased trees. Jancarik's method was modified by evaluating only the current year needles rather than all needles, along with using the following disease symptom ratings to determine disease severity:

0 - No fungus fruiting bodies or disease symptoms observed.

1 - 1 to 5 percent of current year foliage infected.

2 - 6 to 25 percent of current year foliage infected.

3 - 26 to 50 percent of current year foliage infected.

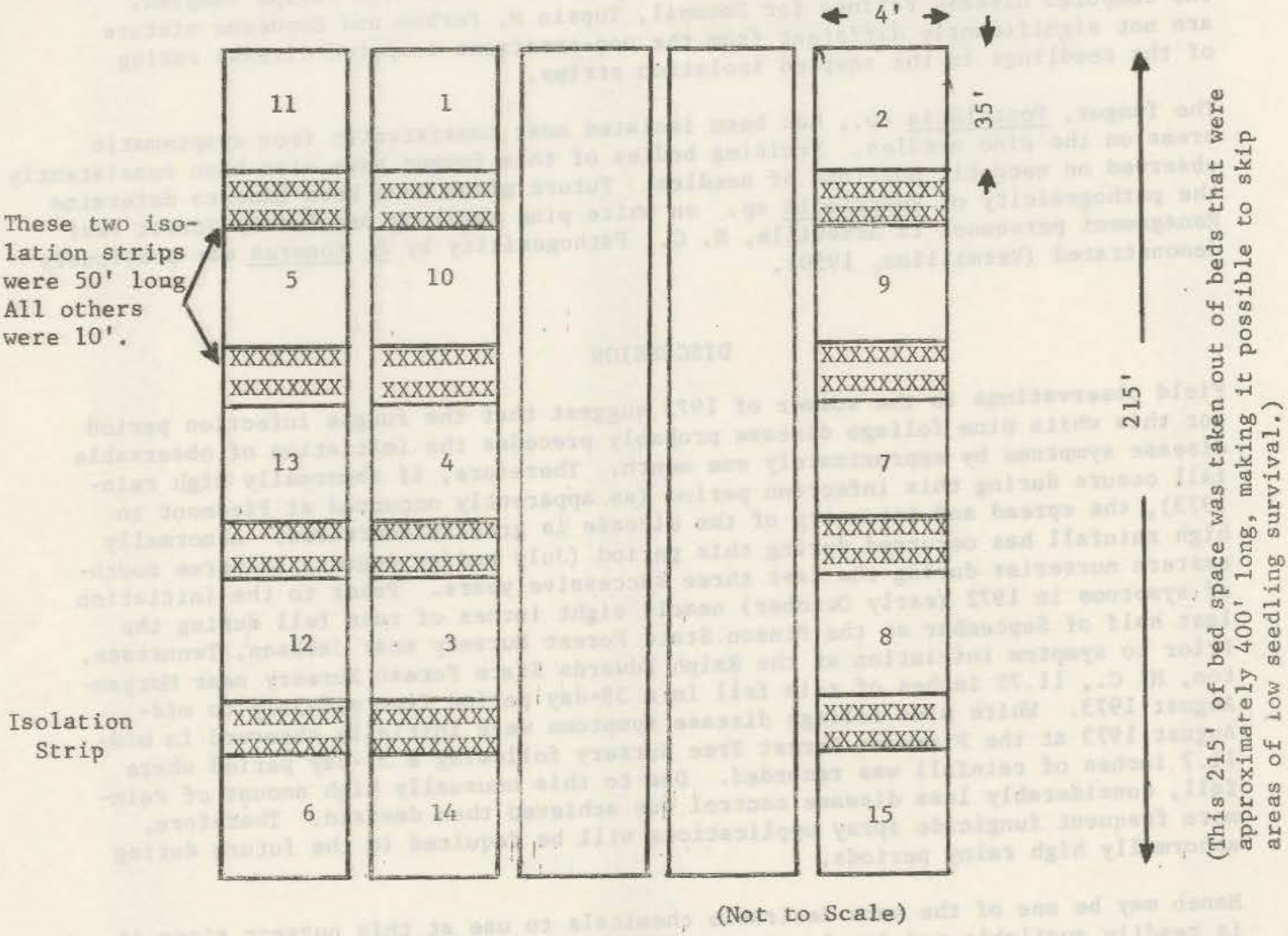
4 - 51 to 100 percent of current year foliage infected.

5 - Seedlings dead from foliage disease.

Each treatment plot was evaluated by sampling one centrally located 1-foot wide strip (1 x 4 ft.) sample across each plot.

Table 1. Computed disease rates obtained from 15 treated plots and 3 non-treated isolation strips involving 5 fungicidal treatments to control a white pine foliage disease in the Piedmont Forest Tree Nursery near Salem, S. C.

Plot Number	Plot Disease Rate	Treatment Disease Rate	Treatment
1	178		
2	264	232	Daconil
3	260		
4	275		
5	176	231	Topsin M
6	215		
7	261		
8	283	266	Ferbam
9	240		
10	170		
11	181	188	Maneb
12	213		
13	279		Bordeaux
14	224	240	Mixture
15	234		
4 & 10	369		Isolation
15 & 8	247	283	Strips
12 & 13	252		(No Treatment)



Legend:

1, 2, 3	Daconil
4, 5, 6	Topsin M
7, 8, 9	Ferbam
10, 11, 12	Maneb
13, 14, 15	Bordeaux Mixture

Figure 1. Test plot design used at the Piedmont Forest Tree Nursery, Salem, S. C., to test the fungicides Daconil, Topsin M, Ferbam, Maneb and Bordeaux mixture to control a white pine foliage disease.

RESULTS

The results of the control test are summarized in Table 1. Maneb was the most effective of the five treatments tested. The computed disease rate for the Maneb treatment was 188, which is significantly less than the 283 disease rate computed for the non-treated seedlings in the three isolation strips sampled. The computed disease ratings for Daconil, Topsin M, Ferbam and Bordeaux mixture are not significantly different from the non-treatment computed disease rating of the seedlings in the sampled isolation strips.

The fungus, Pestalotia sp., has been isolated most consistently from symptomatic areas on the pine needles. Fruiting bodies of this fungus have also been consistently observed on necrotic portions of needles. Future plans have been made to determine the pathogenicity of Pestalotia sp. on white pine seedling needles by Forest Pest Management personnel in Asheville, N. C. Pathogenicity by P. funerea was previously demonstrated (Vermillion, 1950).

DISCUSSION

Field observations in the summer of 1973 suggest that the fungus infection period for this white pine foliage disease probably precedes the initiation of observable disease symptoms by approximately one month. Therefore, if abnormally high rainfall occurs during this infection period (as apparently occurred at Piedmont in 1973), the spread and intensity of the disease is greatly increased. Abnormally high rainfall has occurred during this period (July and/or August) in three southeastern nurseries during the last three successive years. Prior to the initiation of symptoms in 1972 (early October) nearly eight inches of rain fell during the last half of September at the Pinson State Forest Nursery near Jackson, Tennessee. Prior to symptom initiation at the Ralph Edwards State Forest Nursery near Morganton, N. C., 11.75 inches of rain fell in a 39-day period from mid-July to mid-August 1973. White pine foliage disease symptoms were initially observed in mid-August 1973 at the Piedmont Forest Tree Nursery following a 35-day period where 11.7 inches of rainfall was recorded. Due to this unusually high amount of rainfall, considerably less disease control was achieved than desired. Therefore, more frequent fungicide spray applications will be required in the future during abnormally high rainy periods.

Maneb may be one of the more desirable chemicals to use at this nursery since it is readily available and is already being used at the Piedmont Forest Tree Nursery to control other diseases. Even though Daconil and Bordeaux mixture did not prove to be effective in this test, they have been shown in other studies to be effective fungicides for controlling similar foliage diseases (Kais, 1972 1/; Parris, 1969; and Affeltranger, 1973) and are both registered for conifer foliage diseases of this type. Finally, due to the large variation between the treatment replications, it may be more desirable and advantageous in future studies of this nature to establish a minimum of four treatment replications in a randomized block versus a completely random design. This type of design should also help minimize possible significant interplot and interbed variations in fungus spore dispersal patterns, microclimatic influences, host susceptibility, and subsequent disease rates.

1/ Personal communication between C. E. Cordell, Division of Forest Pest Management and A. G. Kais, Southern Forest Experiment Station, relating recent unpublished research results.

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